A BETTER UNDERSTANDING OF FILTRATION SYSTEMS THROUGH TRAINING AND EXPERIENCE

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I. Abstract

This paper will discuss two HEPA filtration systems at the United States Enrichment Corporation's Portsmouth Gaseous Diffusion Plant. Topics will include initial inspection, initial installation configuration flaws, project upgrades, establishment of design bases, and the implementation of a HEPA filtration systems program. This paper will also illustrate and discuss certain features of the inadequate original designs, and the corrective measures that were taken to bring the systems into compliance with the newly implemented HEPA filtration program. A better understanding of the principles laid out in industry standards was gained. Also, the need for trained technicians who are knowledgeable of the testing methods and standards was recognized.

II. Introduction

In October 1995, the plant's HEPA filtration systems program was upgraded. A project was initiated that would upgrade the HEPA systems and establish a program to provide guidance in areas such as environmental control, engineering, health physics, industrial hygiene, and field testing. A governing body, the High Efficiency Filtration Systems Group (HEFSG), which would be responsible for the high efficiency filtration systems of the plant and would control issues such as upgrades, design bases, applications, etc. Consultants were brought on board to assist in the characterization and initial inspection of the existing systems. During the course of this characterization, each system was studied to determine suitability for its intended use. Some systems required major retrofit and others required only minor modifications. A few of them were recommended to be removed from service or to be downgraded from HEPA classification. All recommendations were compiled and presented to the HEFSG. Upon consideration of the consultant's recommendations, the board presented its proposal as to which fixed systems should be upgraded or retrofitted, which systems should be downgraded, and which systems should be removed from service. Those recommended for upgrade or retrofit were taken through the modification process and were ultimately brought into compliance with the newly adopted standard of testing

III. Initial Installation Configuration Flaws

The first system, known as the Small Parts Dismantling Booth, was constructed in 1978 and used a 3-high by 6-wide array with pre-filters. It was located on a platform 10 feet above the floor and was installed with no test capabilities. The limited space surrounding this filtration unit required that one of the doors be completely removed in order to gain access to the filters located inside the housing.

Before the initial inspection of this system, an attempt was made to upgrade the system with minor duct modifications. The ductwork connected to the housing was equipped with multiple test holes so that transverse test readings could be taken. When the in-place testing began, the system failed by a large margin. The filters were repositioned and the system was re-tested. Again, it failed. With no means of inspecting the inside of the housing, the ductwork closest to the filters was removed to allow inspection. A 3-inch wide gap was discovered between the frames of two 3-high by 3-wide filter arrays. This was obviously the source of the high downstream readings. A cover plate was fabricated and installed, the ductwork was reassembled, and the system was re-tested. The system failed again, but the readings had improved considerably.

The source of the leakage was not readily visible; a plan was developed to enter the ductwork and perform a surface scan to find filter bypass or other leakage. An access door was installed and two test technicians entered the ductwork in supplied air protective equipment and performed a scan of the entire cross-section of the filter housing. Several leaks, equally distributed between the seams in the housing and the filter seating surfaces, were detected and corrected. Since this system was one scheduled to be replaced, it was deemed acceptable to make temporary repairs, and the leaks were patched using silicone caulk as sealant and neoprene rubber strips as gaskets. The filter system eventually passed the in-place efficiency test.

The second system, called the Blue Room, was installed in 1953 with a 4-high by 3-wide array with no pre-filters. This unit also had limited accessibility; at some time in the past, a second fan had been installed in a parallel configuration with the original fan. It was readily apparent that this unit had to be replaced. This filtration unit also was installed with no provisions for testing. To further complicate the issue, HF gas was commonly exhausted by this system. The HF was a chronic problem that had caused corrosion of the internal surfaces of the ductwork and filter housing which were fabricated from galvanized sheetmetal. This system, also located about 10 feet above the floor, was inspected and found to be in such poor condition that testing was not even considered. Accessibility was a major concern because of limited space. Therefore, a new location was sought. In addition, a means of combating the effects of HF gas was needed.

IV. Project Upgrades

The Small Parts Dismantling Booth filter unit was replaced in the same location with a more compact 3-high by 3-wide unit that was equipped with test sections. The fewer number of filters was a concern; however, the fan had excess capacity and the airflow was adjusted accordingly. The new unit was considerably heavier, but the existing structure adequately carried the additional load. The smaller-sized unit also provided storage space on the platform.

The Blue Room filter unit was relocated and completely replaced with a skid-mounted 2-high by 1-wide system equipped with an external test section and an absorber section. The new unit and ductwork was fabricated from stainless steel and was connected to a suitable point in the original ductwork system. The new unit used a fan that was sized to provide better airflow than the two original fans combined and it operated on less power.

Since the plantwide HEPA filter upgrade project has been completed, both of these systems are readily accessible and have been tested and operated as intended.

V. Design Bases

One of the main goals of the new HEPA program was to establish a set of design bases for the systems if originals could not be found. The design bases for many of the original HEPA systems of the plant were unknown or uncertain. To compile the design bases for these systems, the HEFSG researched old project records to attempt to determine the design bases. The plant's Final Safety Analysis Report contained references to the Safety Analysis group’s involvment in defining filtration criteria for contamination control, but there were no related documents found that could be used as these criteria.

Along with this historical information, the HEFSG developed a set of design bases founded in contamination control and ALARA principles. With certain exceptions, ASME N509-89[(1)] and ASME N510-89[(2)] were adopted as the design and testing guides. A notable point with regard to these standards is the fact that there are no true “N509” systems on plantsite. All of the HEPA filter systems were designed, fabricated, and installed without the rigor that would normally be associated with nuclear air cleaning systems. Referring to Jacox’s related discussion[(3)], the systems were upgraded so they could be tested “to the intent of N510.”

The above standards and exceptions were incorporated into the plant's new Safety Analysis Report. Various other publications such as ASME AG-1[(4)], ERDA 76-21[(5)], and certain Institute of Environmental Sciences Recommended Practices[(6)] were also employed as design tools.

VI. Implementation of a HEPA Filtration Systems Program

In addition to establishing design bases, the HEPA filtration systems program required trained personnel and adequate equipment to perform in-place testing. This would be critical for supporting the various HEPA systems across plantsite.

Multiple levels of training were provided to the technical element of the HEPA program. The training consisted of airflow principles, data gathering, hands-on use of test equipment, and filtration theory. This training instilled confidence in the technicians, and it enabled them to address complicated field conditions and reduce their dependence on direct supervision.

New modern testing equipment was added to the collection of old but still serviceable instruments. The new equipment quickly became the instruments of choice due to portability and simplicity of operation.

To a great extent, the training and new equipment streamlined the testing process. However, due to the sheer number of units in each facility, unless the test areas were near each other, the test group frequently lost considerable time moving between its test sites. As a result, the test group was not as efficient with its time as it needed to be. This condition was corrected when the Work Control group and the testing group implemented a plan that would further streamline the testing process. The facilities that used several portable HEPA units would arrange to have them available and centrally located so that the test group could perform simultaneous or continuous testing. This essential process worked very well.

Another important aspect of the program is the relationship between the members of the HEFSG. Members of this group consist of representatives from Engineering, Environmental Compliance, Health Physics, Industrial Hygiene, Lab Services (test group), and others as needed. Each member is responsible for a certain portion of the overall program and can be called upon to provide input regarding designs, modifications, procedures, and environmental issues.

VII. Conclusions

After the upgrade/retrofits were completed, the plant benefited from the project because there now existed a defined set of design bases for all HEPA filtration systems. In addition, the plant now had a group of technicians that were fully trained and capable of not only performing testing but also providing technical input to the HEFSG. Additionally, the testing group had obtained the necessary equipment that enabled them to mobilize and set up at the test site within minutes of a service call. And, Work Control practices have been implemented to streamline the testing of several HEPA units in a single site visit.

Two significant conclusions were drawn from the upgrade project. First, it was very clear that several lessons could be learned with regard to design, fabrication, installation, and verification of the typical HEPA filtration system. This led to a heightened awareness of the principles laid out in standards such as ASME N509, ASME N510, ASME AG-1, and ERDA 76-21. Second, but equally important, was the recognition of the need for trained technicians who are knowledgeable of the testing methods and standards.

VIII. References

1. ASME N-509, "Nuclear Power Plant Air-Cleaning Units and Components," ASME, 345 East 47th Street, New York, NY 10017, 1989

2. ASME N-510, "Testing of Nuclear Air Treatment Systems," ASME, 345 East 47th Street, New York, NY 10017, 1989

3. Jacox, J.; "ASME N510 Testing of Non-N509 Systems;" 25th Nuclear Air Cleaning Conference; page 232; 1998; CONF 980803; National Technical Information Service, Springfield, VA 22161-0002

4. ASME AG-1, "Code on Nuclear Air and Gas Treatment," ASME, 345 East 47th Street, New York, NY 10017, 1997

5. ERDA 76-21, "Nuclear Air Cleaning Handbook," 1979 version reproduced by National Technical Information Service, Springfield, VA 22161-0002; 1979

6. IES-RP-CC001.3, "Contamination Control Division Recommended Practice," Institute of Environmental Sciences, 940 East Northwest Highway, Mount Prospect, IL 60056, 1994